RELIEF SLOT FOR COMBUSTION LINER

FIELD OF THE INVENTION

The present invention is directed generally to relief slots defined in combustion liners, and more particularly to an advanced geometry relief slot for relieving hoop stress in structures.

BACKGROUND OF THE INVENTION

Thin wall combustion liners are used throughout the industry in commercial, industrial, and military gas turbine engine applications. The purpose of the combustion liner walls are to provide a pressure drop for mixing and burning of fuel and air inside the gas turbine. The hot air is then directed into the turbine by the liner wall contours. The pressure drop for mixing is provided by the cooling air circuits (holes and slots), the dome and fuel nozzle air swirlers, and the liner dilution holes.

Gas turbine engines have incorporated axially cut keyhole relief slots in the aft seal rings of the combustion liner to reduce the hoop stress. Conventional keyhole slot geometry on combustion liners includes a round or elliptical stop drill hole at the root or base of the slot. Combustion liner aft seal rings are known to suffer from cracks initiating at the keyhole relief slots. These keyhole slots are typically distributed circumferentially around the liner to reduce the hoop stress fight experienced in the combustion liner aft seal ring. However, the shape of the relief slot can tend to contribute to crack initiation and other fatigue cracks in the aft seal rings adjacent to the relief slot because of sharp geometric notches and associated high Kt's (stress concentrations) in the local high hoop stress field.

There is a continuing need for technology development relating to modifying relief slots so as to increase crack initiation and fatigue growth life of the region in the aft seal rings experiencing a high hoop stress. More specifically, there is a continuing need to develop an advanced geometry slot configured for moving the high Kt features of the slot out of a high stress region to specifically enhance component service life. The present invention satisfies this need in a novel and non-obvious way.

SUMMARY OF THE INVENTION

In one aspect of the present invention, a structure configured for relieving hoop stress comprises a wall defining a relief slot therein. The relief slot defined in the wall includes a first slot portion extending from a first end of the wall to a termination point. An arcuate slot portion intersects the termination point of the first slot portion, and a generally circular aperture is defined in the wall at each end of the arcuate slot portion.

In a second aspect of the present invention, a combustion liner comprises an aft seal ring defining a relief slot in a wall of the combustion liner. The relief slot defined in the wall includes a first slot portion extending from a first end of the wall to a termination point. An arcuate slot portion intersects the termination point of the first slot portion, and a generally circular aperture is defined in the wall at each end of the arcuate slot portion.

In a third aspect of the present invention, an aft seal ring of a combustion liner comprises a wall defining a relief slot. The relief slot defined in the wall includes a first slot portion extending from a first end of the wall to a termination point. An arcuate slot portion intersects the termination point of the first slot portion, and a generally circular aperture is defined in the wall at each end of the arcuate slot portion.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cross-sectional view of a gas turbine engine incorporating a combustion liner in accordance with the present invention.

FIG. **2** is a perspective view of a combustion liner.

FIG. **3** is a perspective view of a portion of a combustion liner wall defining a relief slot.

FIG. **4** is an enlarged perspective view of a portion of a combustion liner wall defining a conventional keyhole relief slot.

FIG. **5** is an enlarged perspective view of a portion of a combustion liner wall defining a relief slot embodying the present invention.

FIG. **6** is a plan view of the relief slot of FIG. **5** illustrating a hoop stress field in the vicinity of the relief slot.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** is a cross-sectional view of a gas turbine engine **10** illustrating, by way of example only, a context for implementing the advanced geometry relief slot for relieving hoop stress in accordance with the present invention. The gas turbine engine **10** includes a combustion liner **12** which typically experiences hoop stress generated therein. The advanced geometry relief slot embodying the present invention and to be explained more fully hereinbelow is implemented in, for example, the combustion liner **12** to reduce hoop stress and to prevent or forestall the generation of cracks or the onset of other types of structural fatigue in the vicinity of the relief slot defined in the wall of the combustion liner. For clarity of illustration, FIG. **2** shows an example of a combustion liner **20** separate from other engine components. Although an advanced geometry relief slot can be implemented in a combustion liner of a gas turbine engine, it should be understood that a relief slot in accordance with the present invention can be implemented in other structures or walls that typically experience hoop stress.

FIG. **3** illustrates the location of a relief slot in a portion of a combustion liner. As shown in FIG. **3**, a combustion liner **30** defines a relief slot **32** at an upper end **34** of a wall **36** of the combustion liner. FIG. **4** is an enlarged view of a portion of a combustion liner **40** defining a conventional keyhole relief slot **42** at an upper end **44** of a wall **46** of the combustion liner for relieving hoop stress. The keyhole relief slot **42** defined in the wall or aft seal ring **46** of the combustion liner **40** includes a first slot portion **48** extending from a first end **50** of the wall **46** to a base or termination point **52**. The keyhole relief slot **42** defined by the wall **46** further has a round or elliptical stop drill hole **54** at the base or termination point **52**. As mentioned above, the shape of conventional keyhole relief slots can tend to contribute to crack initiation and other fatigue cracks in the aft seal rings adjacent to the relief slot because of sharp geometric notches and associated high Kt's (stress concentrations) in the local high hoop stress field.

FIG. **5** illustrates a combustion liner **60** having a wall **62** defining an advanced geometry relief slot **64** in an upper portion or aft seal ring **66** thereof in accordance with present invention. The relief slot **64** defined by the wall or aft seal ring **66** of the combustion liner **60** includes a first slot portion **68** extending from a first end **70** of the wall **66** to a termination point **72**. The relief slot **64** defined by the wall **66** further includes an arcuate slot portion **74** intersecting the termina-